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## PATENT SPECIFICATION

697,189

Inventor :—FRANK ARCHER WILLIAMS.

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## COMPLETE SPECIFICATION.

## Improvements relating to the Underground Gasification of Coal.

We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation, established by Statute, of 1 Tilney Street, W.I., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the underground gasification of coal in systems in which a gaseous medium such as air, or mixtures of air and steam and like oxidising gases, is passed through a substantially horizontal gasification channel formed within the coal seam. In systems of this kind, the gasification channel may extend between two rising shafts, one serving as an input shaft by which the gaseous medium is introduced and the other as an off-take shaft from which the combustible gases are collected.

In such systems, as gasification proceeds, it is accompanied by subsidences or falls of the roof and by foaming or slagging of the roof and/or floor, the void left by the coal as it is consumed being partially, but not uniformly or completely, filled in. In the case of a dipping seam, with which this invention is more especially concerned, the zone of gasification works upwards on account of the effect of convection currents tending to bring the hot gases up towards the roof of the gasification channel, the roof being slowly destroyed. However one of the major difficulties encountered is that, as gasification proceeds and the gasification channel effectively deepens, a proportion of the gaseous medium introduced passes through the ash and debris collecting in the lower part of the gasification channel and consequently by-passes the active reaction zone which occupies only the upper part of the channel. The result is that much of the gas produced is burnt in or near the off-take shaft by the by-passing air and the

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potential heat of the said gas is converted into sensible heat underground. During the passage of the hot gases to the surface where they are to be collected, loss of heat to the surrounding rocks occurs and, moreover, the off-take shaft is subjected to extremely arduous conditions of service which shortens its life and also leads to undesired leakage of gas to the surface by the development of a system of cracks surrounding the pipe due to the excessive temperature. Finally under the foregoing conditions when the gases eventually reach the surface, utilisation on the spot becomes essential since otherwise the sensible heat is dissipated and such utilisation calls for the provision of more or less elaborate means of heat exchange at the off-take point and may be otherwise inconvenient.

In an attempt to prevent the gaseous medium from by-passing the reaction zone, sand, cement and like materials have been introduced, through holes bored from the surface, into the void left by the gasification of the coal but it has been found difficult by this method to ensure the even flow of the materials injected to the furthestmost parts of the void and little benefit has resulted.

The object of the present invention is to obtain a better degree of control of the reactions during the gasification process and to this end, according to the invention, the passage of the gaseous medium through the ash and debris which collects in the lower part of the gasification channel is prevented by ensuring that the said lower part of the channel is filled with water, the level of the water being maintained at such a height as to keep the gaseous medium in close contact with the burning coal and yet not high enough to quench the gasification process.

In carrying the invention into effect, in the case of a dry seam, water may be deliberately introduced into the gasification channel

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but more usually the desired result may be achieved in a simple manner by ensuring that the water usually present in the seam or in the surrounding strata is made to serve a useful purpose instead of being a nuisance and having to be pumped out. The preferred method is to arrange that the horizontal channel between the rising shafts and in which gasification is to be initiated in the seam is at the lowest part of the seam to be gasified. Gasification naturally works upwards as previously mentioned and at the same time the ash resulting from gasification tends to fall away from the burning face to the bottom of the gasification channel. As gasification proceeds and the coal forming the roof of the channel is consumed the channel effectively deepens to a point where by-passing of air through the void commences, this being indicated by a fall in the quality of the gas. At this point it is arranged to cease pumping out the naturally occurring water, and, if necessary, to add further water so as to fill the void left by gasification and thus prevent by-passing.

The invention will now be described with reference to the accompanying drawings which are purely diagrammatic and given solely by way of example. In the drawings Fig. 1 is a vertical section across a dipping coal seam in which an underground gasification system has been established;

Fig. 2 is a section on the line II—II, Fig. 1, illustrating the condition of the system in the early stages of operation; and Fig. 3 is a view similar to Fig. 2 illustrating the same gasification system in later stages of operation.

Referring to the drawings, the coal seam 1 is a dipping seam extending obliquely downwards from ground level 2 through the surrounding earth 3. The gasification channel 4 extends through the seam 1 between a shaft 5 serving for the introduction of the gaseous medium and a shaft 6 through which the products of gasification are taken off. It will be observed that the lower portions of the input and off-take shafts 5 and 6 extend through the seam 1 following the slope thereof.

Extending through the input shaft 5 is a pipe-line 7 (Figs. 2 and 3) including an electrically driven pump 7a used for the control of the level of water at the bottom of the system. In the case of a dry seam, water may be deliberately introduced through the pipe 7 and in the case where water naturally drains into the system, the pipe 7 may be used for the withdrawal of the surplus water.

Extending through the off-take shaft 6 is a pipe 8 connected to any suitable form of hydrostatic head device by which the level of water in the channel 4 may be measured. One suitable method of measuring the level

of water in the channel 4 consists in blowing air down the pipe 8 and noting the pressure necessary to cause the air to escape from the pipe by bubbling through the water. The dimensions of the pipe 7 being known, the depth of immersion may then be calculated.

Referring more particularly to Figs. 2 and 3, in the early stages of the gasifying process the height of the gasification channel 4 is not substantially greater than the diameter of the original bore and but little ash and debris is to be found on the floor of the said channel such ash and debris being indicated by 9, (Fig. 2). As gasification proceeds the coal forming the roof of the channel 4 is consumed so that the height of the said channel increases while considerable quantities of ash and debris collect on the floor of the channel as indicated by 9a (Fig. 3). Thus in the later stages of the gasification process, unless precautions are taken, much of the gaseous medium introduced through the shaft 5 will pass through the loose ash and debris 9a and by-pass the active gasification zone at the upper part of the channel.

In order to obviate this disadvantage, according to the present invention, the lower portion of the channel 4 is kept filled with water the surface of which is indicated at 10 (Fig. 3). If the system is too dry water is pumped in through the pipe 7; if the quantity of water which drains in from the seam and surrounding strata is excessive the excess water is withdrawn through the said pipe 7.

The water level is adjusted, so far as is practicable, so that the surface of the water is not exposed to direct radiation from the gasification zone but is partially or wholly obscured by the ash and debris. If the water level is allowed to rise too far, rapid evaporation will occur and the gasification zone will be quenched. On the other hand a limited amount of evaporation can serve the same purpose as the introduction of steam with the gasification medium when it is desired to raise the calorific value of the gas produced.

What we claim is:—

1. A method of gasifying coal underground in a system comprising a substantially horizontal gasification channel extending through the coal seam, wherein the passage of the gaseous medium through the ash and debris which collects in the lower part of the gasification channel is prevented by ensuring that the said lower part of the channel is filled with water, the level of the water being maintained at such a height as to keep the gaseous medium in close contact with the coal being gasified and yet not close enough to quench the gasification process.

2. A method of gasifying coal under-

ground as claimed in Claim 1 and applicable to a relatively dry coal seam, wherein water is deliberately introduced into the lower part of the gasification channel.

- 5 3. A method of gasifying coal underground as claimed in Claim 1 and applicable to a coal seam where water is naturally present in the seam or in the surrounding strata, wherein instead of pumping out all the water the level of the water is controlled

to ensure that the gaseous medium is kept in contact with the coal being gasified.

4. A method of gasifying coal underground substantially as hereinbefore described with reference to the accompanying drawings. 15

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# PROVISIONAL SPECIFICATION.

## Improvements relating to the Underground Gasification of Coal.

We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation, established by Statute, of 1 Tilney Street, London, W.1, do hereby declare this invention to be described in the following statement:—

This invention relates to the underground gasification of coal in systems in which a gaseous medium such as air, or mixtures of air and steam and like oxidising gases, is passed through a substantially horizontal gasification channel formed within the coal seam. In systems of this kind, the gasification channel may extend between two rising shafts, one serving as an input shaft by which the gaseous medium is introduced and the other as an off-take shaft from which the combustible gases are collected. One such system is disclosed in the co-pending Patent Application 15989/49 (Serial No. 674,082).

In such systems, as gasification proceeds, it is accompanied by subsidences or falls of the roof and by foaming or slagging of the roof and/or floor, the void left by the coal as it is consumed being partially, but not uniformly or completely, filled in. In the case of a dipping seam, with which this invention is more especially concerned, the zone of gasification works upwards on account of the effect of convection currents tending to bring the hot gases up towards the roof of the gasification channel. However one of the major difficulties encountered is that, as gasification proceeds, a considerable proportion of the gaseous medium introduced passes through the ash and debris collecting in the lower part of the gasification channel and consequently bypasses the active reaction zone. The result is that much or all of the potential heat of the products of gasification is converted into sensible heat underground. During the passage of the hot gases to the surface where they are to be collected, loss of heat to the surrounding rocks occurs and, moreover, the off-take shaft is subjected to extremely arduous conditions of service which shortens its life and also leads to undesired leakage

of gas to the surface by the development of a system of cracks surrounding the pipe due to the excessive temperature. Finally under the foregoing conditions when the gases eventually reach the surface, utilisation on the spot becomes essential since otherwise the sensible heat is dissipated and such utilisation calls for the provision of more or less elaborate means of heat exchange at the off-take point and may be otherwise inconvenient.

In an attempt to prevent the gaseous medium from by-passing the reaction zone, sand, cement and like materials have been introduced, through holes bored from the surface, into the void left by the gasification of the coal but it has been found difficult by this method to ensure the even flow of the materials injected to the furthestmost parts of the void and little benefit has resulted.

The object of the present invention is to obtain a better degree of control of the reactions during the gasification process and to this end, according to the invention, the passage of the gaseous medium through the ash and debris which collects in the lower part of the gasification channel is prevented by ensuring that the said lower part of the channel is filled with water, the level of the water being maintained at such a height as to keep the gaseous medium in close contact with the burning coal and yet not close enough to quench the gasification process.

In carrying the invention into effect, in the case of a dry seam, water may be deliberately introduced into the gasification channel but more usually the desired result may be achieved in a simple manner by ensuring that the water usually present in the seam or in the surrounding strata is made to serve a useful purpose instead of being a nuisance and having to be pumped out. The preferred method is to arrange that the horizontal channel between the rising shafts and in which gasification is to be initiated in the seam is at the lowest part of the seam to be gasified. Gasification naturally works up-

wards as previously mentioned and at the same time the ash resulting from gasification tends to fall away from the burning face to the bottom of the gasification channel. 5 As gasification proceeds the channel widens to a point where by-passing of air through the void commences, this being indicated by a fall in the quality of the gas. At this point it is arranged to cease pumping out the naturally occurring water, and, if necessary, to add further water so as to fill the void left by gasification and thus prevent by-passing. The level of water in the channel can be measured from the surface of the 10 ground by means of a hydrostatic head device. The water surface should be adjusted so that it is not exposed to direct radiation from the gasification zone but is partially or wholly obscured by the ash and debris. If the water level is allowed to rise too far 20 rapid evaporation will occur and the gasification zone will be quenched. On the other hand a limited amount of evaporation can serve the same purpose as the introduction of steam with the gasification medium when 25 it is desired to raise the calorific value of the gas.

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